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HAWAII AGRICULTURAL EXPERIMENT STATION.

J. G. SMITH, SPECIAL AGENT IN CHARGE.

BULLETIN No. 12.

THE MANGO IN HAWAII.

BY

J. E. HIGGINS,

HORTICULTURIST, HAWAII AGRICULTURAL EXPERIMENT STATION.

UNDER THE SUPERVISION OF

OFFICE OF EXPERIMENT STATIONS,

U. S. Department of Agriculture.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1906.

A GROUP OF MANGO TREES.

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HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

[Under the supervision of A. C. TRUE, Director of the Office of Experiment Stations, United States Department of Agriculture.]

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LETTER OF TRANSMITTAL.

HONOLULU, HAWAII, *January 30, 1906.*

SIR: I have the honor to transmit herewith and recommend for publication as Bulletin No. 12 of this station a paper relative to The Mango in Hawaii, prepared by Mr. J. E. Higgins, horticulturist.

This paper constitutes an important contribution to the literature of tropical agriculture, for the mango is to these islands what the apple is to people of the colder climes, a delicious fruit, so abundant in its season as to be within the reach of all. The mango is destined to become an important feature in our fruit export trade as its lusciousness and finer qualities of form, coloring, and flavor become more generally known.

The illustrations accompanying this bulletin are necessary to the proper understanding of the text by residents of the temperate mainland, to whom the mango now appeals more as a tropical curiosity than on its merits.

Very respectfully,

JARED G. SMITH,
Special Agent in Charge,
Hawaii Agricultural Experiment Station.

Dr. A. C. TRUE,
Director, Office of Experiment Stations,
U. S. Department of Agriculture, Washington, D. C.

Recommended for publication.
A. C. TRUE,
Director.

Publication authorized.
JAMES WILSON,
Secretary of Agriculture.

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THE MANGO IN HAWAII.[a]

INTRODUCTION.

The mango has been called "the king of fruits." With its unique forms, rich coloring, and luscious taste it certainly deserves a high rank among fruits. Its true merits, however, are known to but few, since the better varieties are rare. The commonest of the seedling varieties grow almost wild in tropical lands and produce an abundance of fruit of very indifferent or disagreeable flavor and texture, and which have given rise to the damaging epithets that have at times been applied to the mango. It would be as fair to judge the apple by half-wild seedlings as to form an estimate of mangos by those sorts which abound in fiber and turpentine flavor. It is true that some varieties which have the turpentine flavor quite pronounced are highly esteemed by those who have become accustomed to them, but this is an acquired taste. Most of the finer kinds which are now propagated by graftage appeal to the consumer at first acquaintance.

Since it has been demonstrated that mangos can be kept for at least several weeks and can be transported long distances (see p. 18), and since the trees in these islands produce fruit in its perfection abundantly, the questions arise: Why should not the fruit be grown commercially in Hawaii and marketed on the mainland of the United States? Why should not the better varieties be propagated more generally? There seems no greater obstacle in the way of establishing a mango industry in these islands than has confronted orange growing in Florida and California or many of the other horticultural enterprises which have now assumed very large proportions.

THE MANGO FROM A BOTANICAL STANDPOINT.

The mango (*Mangifera indica*) is one of about thirty species of the genus Mangifera, belonging to the natural order Anacardiaceæ. Other common representatives of this family in Hawaii are the Wi-fruit[b] (*Spondias dulcis*), the Cashew nut (*Anacardium occidentale*), and the pepper-tree (*Schinus molle*). *Mangifera indica* is the only species of the genus bearing fruit of much value, although others produce fruit which is eaten by the natives of India and elsewhere.

The native home of the mango is thought to be the region at the base of the Himalayas,[c] whence the species has spread to almost all

[a] U. S. Dept. Agr., Bureau of Plant Industry Buls. 28 and 46 treat of the culture of mangos, particularly in Porto Rico and Florida.

[b] Pronounced Vee fruit.

[c] De Candolle, Origin of Cultivated Plants, p. 200.

parts of the tropical world. Its cultivation in India extends to the most remote antiquity. De Candolle believes that it was first introduced in the New World in Brazil. It was taken from there to Barbados about the middle of the eighteenth century. It was probably introduced to Hawaii for the first time from Mexico, but more recently introductions have been made from various parts of the world, notably India, the Philippines, and Jamaica.

SOIL.

The mango is not exacting in its soil requirements, demanding only that it should be deep, fairly rich, and well drained, conditions which are required by most fruit trees. Though it requires a liberal amount of moisture it is not tolerant of wet, unaerated soil. The tree thrives in either light or heavy soil.

CLIMATE.

The mango is distinctly a tropical tree and must be protected from frost or even chilly temperatures if it is expected to do its best. For this reason in part the lower elevations of these islands are better suited to it than the higher lands, since the Hawaiian climate is scarcely tropical; yet up to several hundred feet the tree produces fair crops, and even at quite high altitudes grows well, but without bearing freely. As to the moisture requirements, the mango is better suited to an irrigated region than to one of natural rainfall, because of the bad effects of rain at flowering time, and indeed throughout the entire life of the tree where the mango blight [a] is known; and, further, because it is a distinct advantage to be able to apply water when it is most needed and withhold it when it would do harm. Wind retards growth and is destructive, especially to the young foliage and to the flowers and fruits. It is advisable, therefore, to select a site sheltered from strong winds or to provide wind-breaks.

PROPAGATION.

Mangos may be propagated by seedage and graftage.

SEEDAGE.

The simplest method of propagation is by seeds, but this has the disadvantage of being unreliable in reproducing the exact variety. There is less variation in mango seedlings than in the case of alligator pears, or avocados, as they are more properly called, but there is no certainty of seed reproducing its variety. This is partly because of the natural habit of variation and partly because the flowers are crossed frequently with foreign pollen. The greater number of the mangos grown in this and every other country, however, are seedlings, and this method will probably prevail for some time to come. It is

[a] A disease due to the fungus Colletotrichum. See page 22.

in fact the only means by which trees can be started for stock into which to graft or bud the best varieties.

SELECTION OF SEED.

In the selection of seeds for planting when it is intended not to bud the stock a great deal of care should be taken. Even when the stock is to be grafted or budded the seeds should not be collected without excluding all weak specimens, but when the seed is intended to produce a tree which will bear fruit of its variety every effort should be made to plant one of the best. For this purpose use only seeds from trees known to produce superior fruit in liberal quantities. It is more important to consider the general character of the whole tree and the fruit which it produces than the good qualities of some individual fruit which may have grown on a tree which has produced only a few specimens. When the seedlings appear, the weaker ones should be thrown out and the stronger kept. Disappointment may be the lot of those who plant the seeds of the finer inarched varieties with the hope of securing the same sorts. Choice seedling varieties will be more likely to reproduce their kind approximately than will the kinds which have been constantly reproduced by budding or grafting. Nevertheless, some of the Indian varieties are so superior that it is well worth while to plant their seeds for the few fine seedlings which are likely to result.

THE LONGEVITY OF SEEDS.

The mango seed is short lived and yet it may be preserved longer than is often stated. It is not an uncommon statement that mango seed is useless after about ten days. To determine the length of life of the ordinary seed without any special provision being made to preserve it the following experiment was undertaken: From ten to twenty-two seeds were removed from the fruits on each of the following dates: July 28, 29, 30, 31, August 3, and August 7. These were washed, dried, and placed in manila envelopes in a tin box. On September 7 these seeds were removed from the envelopes, taken from the husks, and planted. Some of those removed on July 29 had become moldy, probably due to improper drying. The following table shows the results at planting time:

Results of tests of vitality of mango seeds.

Record number.	Removed from fruit.	Days between removal of seed and planting.	Number of seeds in lot.	Number of seeds in apparently good condition.	Number of seeds spoiled.	Percentage of seeds in apparently good condition.
271	July 28	41	14	9	5	64
272	July 29	40	12	1	11	8
274	July 30	39	22	19	3	86
275	July 31	38	10	7	3	70
276	Aug. 3	35	10	8	2	80
273	Aug. 7	31	10	6	4	60
Total			78	50	28	64

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It will be observed that 64 per cent of the seeds which were forty-one days old were in apparently good condition, and of the whole lot, including those injured by molding, 64 per cent seemed to be in suitable condition for germinating. An accident has prevented each of these lots being tested separately to determine the percentage of plants they would produce, but on October 19 a record was made showing that of the 50 seeds planted 34 have grown, which is the equivalent of 43.5 per cent on the original 78 seeds. Thus 43.5 per cent of seeds, varying from thirty-one to forty-one days old, have produced good plants. It is probable that the life of these seeds could have been very greatly lengthened if special care had been taken to maintain the proper degree of moisture in them, which might be done by packing them in powdered charcoal, for example.

REMOVING THE HUSKS.

The tough woody husk inclosing the seed should be removed immediately before planting. This may be done by cutting the edge and prying it open, being a little careful not to injure the seed within. By this means it is possible to avoid planting weevil-infested seed (see p. 24) and the unshapely plants which occasionally result from the struggle of the seedling in getting out of the husk. By this means also seed containing but one embryo, which are regarded as the strongest, may be selected. A still further advantage is gained in the time required for germination. A simple experiment has been made at this station to determine the relative gain in time by this treatment of the seeds. On July 31, 1905, nineteen seeds of different varieties were planted after removing the husks and an equal number of each variety without being so treated. Careful notes were made of the date of the first appearance of the seedlings above ground. The most rapid germination of those within the husks was twenty-eight days, while in the case of those without the husks it was only nine days. The average time required by the untreated lot was 39.7 days, while in the case of the others it was only 17.9 days, showing an average gain of 21.8 days.

PLANTING THE SEEDS.

The seeds should be planted about an inch and a half deep in fairly light soil in pots or boxes which are well provided with drainage. If pots are used, quite small ones will do at first, transferring to larger pots as the plants increase in size. The use of pots is preferable to planting in the open, because by this means the plants can be placed where they will receive some shade and protection from the wind as well as better care while young. The most natural position for the seed is on its side. The results of planting seeds in different positions with the husks not removed are shown in Plate I, figures 1, 2, and 3. In the case of those placed on the convex or on the concave edge it will

FIG. 1.—PLANTS FROM UNHUSKED SEEDS PLACED ON THEIR SIDES.

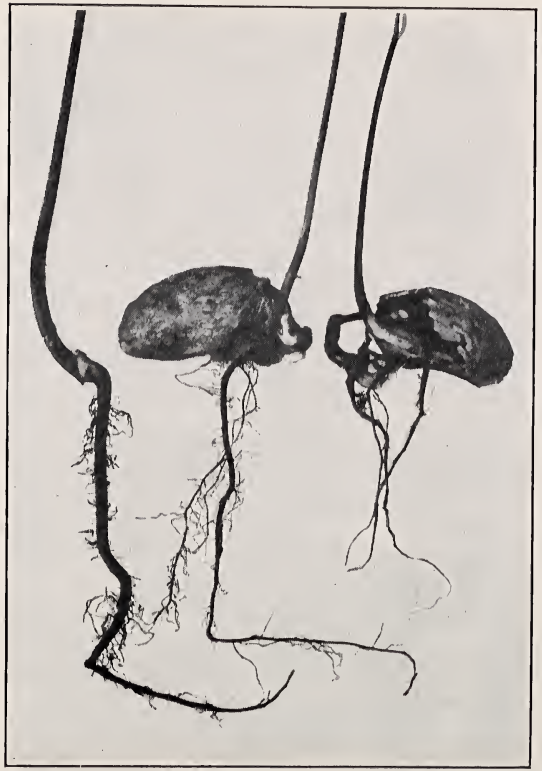

FIG. 2.—PLANTS FROM UNHUSKED SEEDS PLACED ON THE CONCAVE EDGE.

FIG. 3.—PLANTS FROM UNHUSKED SEEDS PLACED ON THE CONVEX EDGE.

be seen that the roots have experienced difficulty in getting out of the husk. Those planted on the side have made the best seedlings. The planter should watch for the appearance of black aphides (Aphididæ), very minute sucking insects, which are likely to escape the notice of the careless observer and which infest chiefly the end of the growing stem. They may be destroyed by a few applications of whale-oil soap in the proportion of one-half pound of soap to one gallon of water. "Dissolve the soap in hot water and apply, while still warm, with a spray-pump."[a]

GRAFTAGE.

CHIEF MATERIALS AND TOOLS.

The chief materials and tools which will be found useful in graftage are grafting wax, waxed cloth, raffia, a sharp knife, perhaps also a double-bladed knife made for this special use, a fine saw, and a 1½-inch chisel. Grafting wax may be made by any one of many receipts, but that composed of four parts resin by weight, two parts beeswax, and one part tallow can be recommended, and is easily made by placing these ingredients in a pot over a fire and melting them together. When thoroughly mixed, pour the contents into a bucket of cold water and when cool enough pull with greased hands until quite light in color. Divide it into sticks of convenient size and it is ready for use. It becomes hard, but softens rapidly when in use by the heat of the hands, which must always be smeared with tallow or other grease.

A liquid wax which may be applied with a brush or swab is made as follows: Melt in a good-sized pot over a fire 1 pound of the best white resin and 1 ounce beef tallow. After removing from the fire add slowly 8 ounces of alcohol. Keep it in closed bottles when not in use. This is known as Lefort's liquid grafting wax.

Waxed cloth for bandages may be made by dipping strips of thin calico or muslin in melted paraffin, which may be purchased at any drug store.

A sharp knife is essential to good work in any form of budding. A knife with two parallel blades about an inch and a half apart will be convenient to mark the exact length of the section of bark as well as to cut it. Such an instrument has been made at this station by removing the blades of two shoemaker's knives and binding them to each side of a wooden handle about one and a half inches thick. Such a knife is not an essential, though it may be found convenient if much budding is to be done.

Raffia, the fiber of a palm, is a standard tying material used by propagators, and may be purchased from most nurserymen or seedsmen. Other strong, pliable material, if it is soft and will not injure the bark, such as woolen yarn, may be substituted where only a few buds are to be set.

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[a] See Hawaii Experiment Station Bul. 3.

BUDDING

Budding is coming to be one of the important means of propagating the finest varieties. Until recently it has not been regarded as practicable to bud mangos, and, in fact, the shield method, which is most commonly used with fruit trees, does not seem adapted to this species, but some forms of patch budding have given satisfaction. The writer has used with success the square patch bud (Pl. II, fig. 1), which is described below. Though this type of budding is quite old, the credit for discovering its adaptability to the mango is due to Mr. G. W. Oliver,[a] of the United States Department of Agriculture, and to Mr. H. Knight,[b] of Queensland, who seem to have applied it at about the same time and independently of each other.

HOW TO PERFORM THE WORK.

Select for a stock a stem or a branch an inch or more in diameter which is old enough to have lost its leaves. Remove from this at the desired point a piece of bark about an inch and a half long and three-quarters of an inch wide. Remove from a branch of the superior variety another piece of bark containing a fresh bud and trim it so that it will exactly fit into the place from which the first piece of bark was removed. This bud also must be taken from mature wood of about the same size as the stock or larger. If the sap is very active these pieces of bark will readily slip out when the margins are cut with a knife, but when there is less activity the use of the saw and chisel will be found an advantage. After cutting the ends of the patch with the saw place the chisel first on one side of it and then on the other, with the beveled edge toward the patch, and strike it with a firm blow. Place the bark containing the bud in the opening prepared for it, bind it with raffia or some soft material firmly in place, but not too tight, and besmear the edges with grafting wax. The whole stem for several inches above and below the bud should now be completely covered with waxed cloth, leaving only the bud itself open to view. Beginning from the lower end, wrap it about the stock, overlapping each time, so that it will shed water. In some of the upper folds place the petiole or "stem" of a leaf, allowing the blade to hang down over the bud and shade it. In the course of about two weeks this binding may be removed, and if the bark and bud are still fresh the union has probably been effected. It is best, however, not to loosen the raffia with which the bud was tied in place until it is evident that the growth of the stem is making it too tight. Buds are sometimes lost by removing the binding too soon. When it is certain that a union has been effected the stock should be cut off 4 to 6 inches above the new bud, which will soon start to grow. After it has made two or

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[a] U. S. Dept. Agr., Bureau of Plant Industry Bul. 46.

[b] Queensland Agr. Jour., 7 (1900), Nos. 1, p. 41; 2, p. 149.

FIG. 1.—A PATCH BUD WHICH HAS MADE ITS FIRST FLUSH.

FIG. 2.—CLUSTERS OF YOUNG FRUITS FROM FLOWER BUDS WHICH HAVE DEVELOPED IN THE AXILS OF THE LEAVES.

three flushes cut off the stem just above the bud with a sloping cut. Plate II, figure 1, shows a patch bud which has made its first flush.

THE TIME FOR BUDDING.

It is usually regarded as essential that budding be performed when the sap is moving freely, since only at this time can the bark be easily removed without rupturing the delicate cell structure. This condition exists several times throughout the year, particularly in young growing trees which are not producing fruit, and is heralded by the bursting of the buds and the appearance of very small new leaves. The operation should be performed before the new growth has made much progress. This may be practiced on the main stem of young trees and on the branches of trees several years old. Knight reports having had success in budding mangos during their resting period.

GRAFTING.

Grafting has been practiced for a long time in India, but ordinary grafting has proved more difficult than budding. A modification of grafting, however, which is usually known as inarching, or grafting by approach, is the easiest method by which the finer varieties may be propagated, or the method requiring the least skill.

INARCHING.

Inarching consists in bringing together the seedling and a young growing branch of the tree of the desired variety in such a manner that they unite while each is on its own roots. To perform this operation, place the seedling, which must be in a pot, tub, or box, in such a position that the twig of the superior variety may be brought close to it. It may be necessary to build a platform to elevate the seedling. With a sharp knife remove a thin layer of wood and bark about 3 to 4 inches long from one side of the seedling and from the nearest side of a branch of the desired variety about the same size, making the two surfaces flat. Place these two flat surfaces together, so that the two barks will be in contact, at least on one side; tie them firmly and apply a little grafting wax. After a time these two pieces will grow together, and the branch of the desired variety may be cut off just below the union and the top of the seedling just above the union, which will leave the branch of the superior variety growing upon the seedling roots. It is advisable to perform this operation while the seedling stock is young. When about six months old it will be in good condition. When allowed to remain too long in the pot the roots of the seedling become cramped and may never recover from the effects. The only satisfactory method of treating such a stunted tree is to plant a seed beside it and inarch the seedling and the older plant, thus getting the latter on a new root system.

STEM GRAFTING.

Stem grafting, sometimes improperly called crown grafting, is said to be practiced in India with considerable success by those who have had experience in the art. It consists in cutting off a tree about eighteen inches from the ground and inserting scions of the desired variety between the bark and the wood. The tree, it is said, should not be more than a foot in diameter. It is usually cut off about a month before the operation of grafting is to be performed, and when the season for grafting has come a few inches more are removed from the top of the stump before inserting the scions. With a sharp knife a slit is made in the bark from the top of the stump downward for several inches. Well-matured shoots of the previous season's growth are selected from the tree of the desired variety and prepared for inserting by cutting the lower 6 inches or so into the form of a wedge with one side flattened and the other side slightly rounded. With a bone paper knife or some instrument of similar shape the bark of the stock is gently raised at the point where the slit was made, and beneath this bark the scion is inserted with the flat side toward the wood. The whole stem of the tree is then bound about with some strong but soft material, so that the scion will be held firmly in place. Grafting wax is now placed upon the top of the stock and the scion and down over the slit in the bark. It is recommended that in dry localities the scion be protected from excessive evaporation by means of what is called a graft protector, which consists of a flower pot inverted and with a hole made in the bottom. Upon the top of this pot a piece of glass is placed and waxed to the pot, thus retaining the air. A shade is erected over the graft protector, which is watered daily or more frequently if necessary. After a time the glass is partially removed, allowing slight ventilation, which is gradually increased. To Mr. G. Marshall Woodrow is due the credit for this device.

LAYERING AND AIR LAYERING.

It is possible to cause a branch of the mango to take root while still attached to the tree. This is performed by the ordinary method of layering, which is commonly practiced in Hawaii with the Bougainvillea and many other plants. A branch conveniently located near the ground is bent down and placed about three or four inches beneath the surface of the soil. Before bending it down, however, a cut should be made in the under side of the branch just below a bud and running upward, so as to form a tongue. In the cut thus made a small stone should be placed to keep it open. Then bending down the branch, secure it in place by means of pegs. After covering it with soil, it should be watered and the ground should be constantly kept moist.

A modification of this process, which is the same in principle, consists in removing a ring of bark from the chosen branch or cutting a

tongue in it and binding about it a quantity of soil by means of burlap. A box may be used, being elevated to receive the branch. Firminger suggests an ingenious method for supplying the ball of earth surrounding the branch with moisture, which is as follows: A flower pot, with a rope drawn through the opening in the bottom and a knot tied within the pot, is filled with water and suspended above, the lower end of the rope passing down and around the ball of earth. The water gradually runs out through the bottom of the pot and follows the fibers of the rope as they pass down and around the ball of soil, keeping the latter constantly moist. Neither method of layering, however, can be recommended for the propagation of first-class trees

TRANSPLANTING.

Seedling trees that are to be budded or which are to remain seedlings should be removed to their permanent positions in the orchard while young. From nine months to a year old will not be too soon. Inarched stock which has been operated upon at about six months old should be moved to the orchard as soon as possible after they are well established and have been trimmed into shape. This will be a few months after they have been removed from the tree where they were inarched. The advantages of moving early are that young mango trees are very much more easily moved than old ones, and that if left too long in the pots the roots will become cramped, as stated above. The best season in which to move mangos will depend upon whether irrigation water is available and upon the rainfall. They must be moved at a time when they are not making active growth, since the very young growth, before it has ripened, wilts easily. If water is available in abundance, any time of the year when they are not growing will be suitable in Hawaii.

To move a tree from a pot to the field it will be best to prepare much larger holes than might at first seem necessary for so small a plant. Holes 2½ feet in each dimension will not be too large. In making these, throw out the surface soil on one side and the subsoil on another and return the surface soil to the botom of the hole, draw in the surface soil from the area immediately surrounding the hole on all sides and distribute the subsoil in this larger area on the surface. It will be well to mix some chemical fertilizer with the soil in the hole. Woodrow[a] recommends that a large quantity of fresh bones be placed in the bottom of the hole. The soil in the pots should be slightly moistened some hours before being taken to the field, so that by inverting the pot and tapping it gently against some solid body the seedling tree with its ball of soil surrounding the roots will slip out from the pot into the hand. Remove any stones from the ball of soil which may have been placed in the bottom of the pot for drainage. Plant the tree in the center of the hole just a little deeper than it stood in the pot,

[a] Woodrow: The Mango, p. 13. London, 1904

pressing the soil gently against that already surrounding the roots. If the soil is not well supplied with moisture it should be watered.

It is sometimes necessary to move a mango tree which has been growing in the open for two or three years or perhaps more. This will be a rather difficult task, requiring considerable skill. The roots should be removed with a ball of earth, as is practiced with citrus trees, and severe cutting back to mature wood is advisable.[a]

An orchard should be planted with regularity and system for the sake of appearance and convenience. Some directions for laying out the land preparatory to planting may be found in Bulletin No. 9 of this station.

The distances apart at which it will be best to plant mangos will depend upon the soil, climate, and varieties. Inarched trees are usually smaller in habit than seedlings. For the latter 30 feet in each direction will not be too wide, but for inarched stock 20 feet on an average will be sufficient. A seedling orchard, however, can not be recommended for commercial purposes. Budded trees, though none are yet known to be very old, may not attain the size of seedlings.

TILLAGE.

Thorough tillage of the soil, keeping it free from weeds and loose on the surface, is as important for the mango as for most other fruit trees. Thorough deep preparation of the soil should begin before the trees are planted and from that time onward the field should be kept clear of grass and weeds and the surface soil should be loose.[b]

IRRIGATION.

As before indicated, liberal moisture must be supplied to the roots, from 50 to 70 inches per year being required, according to the retentive power of the soil and the rate of evaporation. In the case of bearing trees the heaviest irrigation should be given from the time when the flower buds are about to open until several weeks after the fruiting is over, withholding large amounts of water during two or three months preceding the flowering season. This will encourage the formation of flower buds, whereas continued watering would tend to keep the tree growing.

FERTILIZING.

No systematic and careful experimenting with fertilizers for mangos has been done in Hawaii. Experience in India has led to the use of bones in the holes where mango trees are to be planted, and this has produced good results, the bone furnishing both phosphoric acid and nitrogen. In experimental work in fertilizing it will be necessary to reason from the analogies of experiments with other fruit trees,

[a] See Hawaii Experiment Station Bul. 9.

[b] The reader is referred to Bulletins 7 and 9 of this station for further remarks in regard to tillage, the statements made there being applicable also to the cultivation of mangos.

which would point to the probable need of liberal amounts of nitrogen when growth is desired and an increase of potash when fruit production is expected. The time for applying fertilizers to mango trees may prove to be of considerable importance. Large amounts of nitrate of soda or other readily available nitrogenous fertilizer at the time of year when the trees should not be growing or should be maturing fruit buds would tend to throw the tree into growth and defeat the desired end. It would therefore probably be best to apply fertilizers in the early part of the season. Woodrow[a] states that in some of the very rainy districts of India it is customary to apply salt at the rate of about ten pounds per tree several months before flowering should take place. The object of this seems to be to arrest the growth in order that the tree may mature fruit buds.

COVER CROPS.

Though no work has been done with cover crops for mangos in Hawaii, it is reasonable to suppose that their advantages would be the same with this class of fruit trees as with others. Woodrow[b] refers to their use in India and recommends them. If leguminous crops are used they will enrich the soil in nitrogen as well as maintain the supply of humus.[c]

PRUNING.

The mango receives but little pruning after the first two or three years of its growth. If the head has been properly formed the tree will naturally assume a desirable shape, with the central part rather hollow. The varieties differ somewhat in form, some being umbrella-shaped and very symmetrical. To start the tree properly it should be forced to send out side branches within 2 to 3 feet of the ground, which can be effected by arresting the growth of the main stem if it does not branch of itself. Care should be taken to avoid having several branches strike out from the same point, as a tree so formed is in danger of breaking from a heavy load of fruit. If several branches start out from one point the leader and one or two side shoots may be retained and the others suppressed. When the tree gets older about the only pruning that is done consists in removing dead or weak wood in the center of the tree.

Normally the mango produces its flowers on the ends of the branches—that is, the flower buds are terminal. If, however, the ends of the twigs are broken or cut off flower buds will sometimes form in the axils of the leaves (Pl. II, fig. 2). It does not seem impossible that some method of pruning, based upon this suggestion of nature, may be devised which will result in a more uniform production of fruit and the avoidance of overbearing and barren years.

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[a] Woodrow: Gardening in India, p. 14. Bombay, 1889.

[b] The Mango, pp. 11, 14.

[c] See Hawaii Experiment Station Buls. 7 and 9 for further remarks on cover crops.

SEASONS OF GROWTH AND FRUITING.

The seasons of growth and flowering of most species of trees in Hawaii vary with the condition of the weather. In general it may be said, however, that the blooming season for mangos, at or near sea level in the islands, is about January. From this time until about July or August the trees are engaged in the production of fruit, and such trees as are bearing make little or no growth. For most varieties the fruiting season is over in August.

HANDLING THE CROP.

PICKING.

For home use it is generally preferred in Hawaii to gather the fruit from the tree when it is perfectly ripe. This does not correspond with practices in some other mango-producing countries. In India it is preferred to gather the fruit while still hard and store in the dark for ripening. Sometimes it is even buried in the soil. For marketing purposes it is necessary to gather the fruit while yet firm, and if fully grown its excellent flavor will be retained. The fruit should be picked with great care to avoid the slightest bruising, which though it may not be apparent at first will soon disfigure the fruit and cause decay. The stem should be left about an eighth of an inch long. If each mango is wrapped in paper before packing, it will increase the keeping qualities of the fruit. This will be essential if it is intended for shipping. The packing should be in small boxes or baskets, so that the pressure will not be great on any of the fruit.

SHIPPING.

It has been proved that mangos can be satisfactorily shipped long distances. They are shipped from the West Indies to London and even from India to the same market and arrive in good condition. The best conditions for shipping have not been as fully determined as is desirable, but it is certainly important to provide good ventilation to the cases.

COLD STORAGE.

In the matter of temperatures, also, there is much yet to be worked out. The low temperatures to which temperate-zone fruits are subjected will probably prove too cold for best results with the mango and some other tropical fruits. Several experiments have been conducted, but no definite conclusions have yet been reached. The writer placed some mangos of two varieties in cold storage in Honolulu during the season of 1905, where the temperature was such as is maintained for the storage of fruits imported from San Francisco, varying from 34° to 40° F. The following notes were made relative to the experiment: The fruit was gathered and placed in storage on August 7. The chutneys were yellow except one or two which were

marked "green." They were hardly soft enough to eat, however. The so-called "Vanilla" variety was still hard, but was slightly affected with mango blight (see p. 22). The fruit was wrapped in paper only. On August 28 these fruits were examined and found to be in excellent condition. Those of the Vanilla variety were still hard and also the green ones of the chutney variety. On September 7, just one month from the date when the fruit was gathered and placed in storage, it was removed from the ice house. At this date the Vanilla fruits were still firm and in some instances hard except in the spots affected with the mango blight. These spots were supporting a fungus in fine fruiting stage. One was quite soft and spoiled throughout from the numerous points of attack of the disease. The chutney variety was in good condition. A few were rather softer than some people like mangos for eating from the hand, but not riper than many people prefer them. Others of those which were yellow when placed in storage were now in good condition for eating by those who prefer a rather firm fruit. Those marked "green" were still green in color and hard, apparently not having made any progress toward ripening. These were returned to the ice house. The flavor and eating qualities of the fruits at this date do not seem to have been affected in any way by the thirty-one days spent in storage.

The above would seem to indicate that fruits of these varieties can be preserved for at least a month without serious loss, provided that they are sound, free from diseases and from bruises, as all fruit should be when placed in storage. Those that were returned to the ice house on September 7 did not ripen up well when removed. It is possible that a higher temperature would have resulted in as long or longer preservation of the fruit and in proper ripening also of that picked green.

HOW TO EAT A MANGO.

It is quite as important to the consumer to know how to eat a mango with the least inconvenience as it is to the grower to know how to produce it in perfection. Much of the evil reputation which some would fix upon this fruit arises from a lack of knowledge of the methods of handling it. In the case of some people the rind of the mango produces sores upon the mouth and face. Most of the best sorts may be eaten with a spoon, some even separating from the seeds like an avocado pear. To prepare mangos for eating, place them on ice until they have become thoroughly chilled. With a knife cut a ring around the rind a little above the shoulder and another near the opposite end. Then run the knife along the back connecting these two rings. In the case of most varieties the rind may then be readily separated and the pulp may be removed with a spoon or with a knife if quite fibrous. Special mango forks are made by which the fruit may be held, if desired. The fruit is sometimes prepared by peeling and slicing and is served with ice.

THE USES OF THE MANGO.

The first and most important use of the mango at the present time is in the form of fresh fruit. In this as well as in other forms it has considerable food value and forms an important part of the sustenance of the natives of parts of India during the season. In this connection it will be of interest to note the following analysis of mangos made by Dr. E. C. Shorey, chemist of this station:

Analysis of edible portion of mango.

	Per cent.
Water	82.51
Ash	.39
Fat	.01
Fiber	1.45
Protein	.84
Carbohydrates	14.80

The secondary or manufactured products of the fruit are numerous and some are of considerable importance. Perhaps the commonest of these is mango chutney, which is now sold in all the markets of the world, being made chiefly in India. It is now being manufactured on a commercial scale in Honolulu, with promise of success. The following Indian receipt for the manufacture of chutney is published in a bulletin of the Botanical Department of Jamaica.[a]

Three pounds of pulp of the common mango (turned, but not ripe), 3 pounds tamarinds, 2 pounds raisins (weighed after stoning), 8 pounds brown sugar, one-half pound chilies, 2 pounds green ginger, one-half pound garlic or 1½ pounds onions, one-fourth ounce mace, 1 ounce mustard seed, one-fourth ounce cloves, one-fourth ounce pimento, one-half pound table salt. Soak the tamarinds in 2 quarts of the best vinegar, stir them about with a wooden spoon to get the pulp off, and take out the seeds and the leathery part in which they are inclosed. Cut the raisins small. Peel the ginger and grate it. Pound the chilies, garlic, and mustard seed in a mortar, using a little of the vinegar to moisten. Mix all together thoroughly with the mango pulp. It is then ready for use.

It is possible also to make a number of forms of preserves, jelly, and marmalade from the fruit, either fresh or green. Woodrow says: "The possibilities of the mango at the hands of the expert preserve maker with modern appliances are boundless and hitherto have been only touched by the Indian housewife." One of the simplest ways of using the green fruit is in the form of stewed mangos, which may be prepared in the same manner as apple sauce, which it very much resembles in taste.

A bulletin of the Botanical Department of Jamaica[b] gives receipts for the manufacture of marmalade and jelly, and for canning, from which the following is taken:

Marmalade.—Peel and slice the mango, cutting close to the stone, and cook, using plenty of water. Boil until the fruit is thoroughly disintegrated, when the pulp should be run through the colander with the purpose of extracting the "wool." Sugar should now be added to suit the taste (about three-fourths of a pound to the pint of pulp) and the mass boiled until clear, when it should be poured into the molds or jars in which it is to be kept. This marmalade is of a rich golden-yellow color. It retains the form of the mold perfectly, and seems in all respects to satisfy the most exacting taste. In the absence of the experience

[a] Bul. Bot. Dept. Jamaica, No. 46.

[b] Volume I (1894), No. 7, pp. 111, 112.

necessary to test the keeping qualities of mango marmalade it would be the part of wisdom to seal the jars designed for future use, while hot, with wax, or, better yet, with a plug of cotton wool.

Jelly.—For jelly prepare the mangos by slicing as for marmalade, boil the fruit with water, prolonging the boiling only to the extent of extracting the juices. Great care should be taken in boiling, as the mango rapidly "boils to pieces," in which case it is impossible to make satisfactory jelly. Pour off the juice, strain, and boil down to a jelly, an operation that occupies only a few moments, as the mango is rich in gelatinous materials; the pulp remaining after the jelly has been removed may be used to advantage in making marmalade. In the amount of sugar used in making jelly the housekeeper is safe in following old practices in this respect with other fruits. It is impossible to give exact rules in all the operations connected with working up this fruit. In general it will be well in boiling to use water somewhat to excess, and as the mango "cooks" readily, constant watchfulness is needed to prevent burning.

Watt[a] gives the following uses to which the mango may be put:

When green, the stone is extracted, the fruit cut into halves or slices, and (*a*) put into curries; (*b*) made into a pickle, with salt, mustard oil, chilies, and other ingredients; (*c*) made into preserves and jellies by being boiled and cooked in sirup; (*d*) boiled, strained, and with milk and sugar made into a custard known as mango fool; (*e*) dried and made into the native "ambchur," used for adding acidity to certain curries; (*f*)when very young cut into small pieces, mixed with a little salt, and sliced chilies and milk added it forms a "tasty" salad.

When ripe (*a*), it is made into curry which has a sweet acid, not unpleasant, taste; (*b*) it is cut into small pieces and made into salad with vinegar and chilies (the sour fruit is sometimes so used); (*c*) the juice is squeezed out, spread on plates, and allowed to dry. This forms the thin cakes known as amb-sath (Mr. L. Liotard). The kernels are eaten in times of famine, and by the poorest classes in many parts of India they are boiled and eaten with greens. They are also ground into meal and mixed with various other ingredients to form the relish known as am-khatai. When stuffed with coriander, turmeric, and other spices and boiled in mustard oil, they are esteemed a great delicacy.

Numerous uses have been ascribed to the mango as medicine, but on the whole this is rather unimportant.

MANGO BREEDING.

Plant breeding is coming to be a very important element in commercial horticulture. It is, however, only in its infancy as an art, and doubtless will be the instrument of great advancement in many industries. The mango will unquestionably receive the attention of plant breeders in the Tropics, and new varieties, probably superior in many ways to those now known, will be produced. The aim of the mango breeder will be, among other things, to produce a fruit entirely lacking in fiber. It may also be sought to produce a seedless mango and certainly much might be done to lengthen the season by producing extra early and extra late kinds. The results of accidental crosses are manifest to the careful student of this fruit. In fact, the superior varieties from India, which are now propagated by grafting and budding, are probably in large part the result of beneficial but accidental crosses. If this be so, it lends much encouragement to the breeder who will study the characteristics of fruits and so cross them as to combine the the best qualities of two or more different kinds in one variety.

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[a] Dictionary of Economic Products of India, Vol. V, p. 155. London.

DISEASES.

MANGO BLIGHT.

The mango is subject to a disease in Hawaii which has not been generally reported in its cultivation elsewhere. Prof. P. H. Rolfs, of Lake City, Fla., in a recent letter to the writer, states that the disease is present in that State. It manifests itself on the young leaves, the flowers, the twigs, and on the fruits. The young leaves as they appear are exceedingly delicate and form an inviting field for the fungus. These leaves upon a close examination, if infected, will be found to have minute blisters (Pl. III, fig. 1, A) or spots upon them in the early stages of the trouble, and this is followed by a blackening and destruction of the tissues. The flower clusters also, if attacked severely, turn black and drop their flowers (Pl. III, fig. 1, B) or wilt, so that the whole top of the tree sometimes presents a blackened appearance. Hence, the common name mango blight has been applied to the disease. On the tougher tissue of the twigs the disease makes a less marked impression, but nevertheless is able to grow and maintain itself. Terminal flower buds sometimes appear to be destroyed by it. On the fruits the fungus produces blackened spots (Pl. III, fig. 2) which greatly mar its appearance and cause decay to take place when the fruit is ripening. This trouble has been found to be due to the attacks of a fungus of the genus Colletotrichum.[a]

Mango blight has been observed in the islands for three or four years. The writer first made a preliminary study of the affected leaves in Hilo in January, 1904, at which time specimens were forwarded to the laboratory of Vegetable Pathological Investigations under the United States Department of Agriculture in Washington, D. C. These specimens, however, failed to arrive in satisfactory condition, for examination, but have been followed by many others since that date, which have furnished opportunity for the determination of the fungus as the cause of the disease. The exact species is as yet undetermined. During the season of 1904 very few mangos were to be found, owing chiefly to the attacks of this fungus. During the past season the disease, though present, has not been as severe as in 1904.

In connection with what has just been said it will be recalled that the early months of 1904 were marked by heavy rainfall and almost continuous cloudy, wet weather, while the corresponding months in 1905 were exceptionally dry. This unquestionably had much to do with the large crop of mangos produced during the season just passed. This fungus, like others, finds the most inviting conditions for its growth in moist weather. A bottle fly, *Velucella obesa* (family Syrphidæ), of which large numbers are seen on the trees at flowering time,

[a] The author is indebted to Mr. A. F. Woods and his assistants in the Bureau of Plant Industry of the U. S. Department of Agriculture for the determination of this fungus and for the examination of very many specimens of leaves, twigs, flowers, and fruits.

FIG. 1.—MANGO BLIGHT (COLLETOTRICHUM SP.) AS IT AFFECTS THE FLOWERS AND YOUNG LEAVES.

FIG. 2.—MANGO BLIGHT AS IT AFFECTS THE FRUITS.

FIG. 3.—THE WORK OF THE MANGO WEEVIL (CRYPTORHYNCHUS MANGIFERÆ).

may very probably be one means by which the fungus is spread from flower to flower.

Experiments have been conducted by this station in controlling this disease by means of Bordeaux mixture,[a] the standard remedy for similar fungus diseases of plants. These experiments have led to the conviction that it is possible to control the disease by means of this spray. This treatment has been recommended to some growers in the islands, who have also reported success in the control of the disease. It should be applied some time before the buds begin to burst and will need to be continued at more or less frequent intervals throughout the season, according to the character of the weather conditions.

So far as observed, all varieties appear to be equally subject to the disease in the early part of the season, when it attacks the young leaves and flowers, but some varieties appear to be more or less resistant to its attacks upon the fruit. The chutney varieties, for example, appear to be almost free from the disfiguring marks upon the fruit. The fruit of the "No. 9" is also comparatively resistant, while that of the common "Hawaiian" mango and the "Manila" variety is very subject to attack.

MANGO SCAB.

An abnormal condition of young mango fruits, the cause of which is not yet understood, has been observed. The young fruits are disfigured by conical elevations which resemble closely the lemon scab, or Verrucosis.

SOOTY MOLD.

This is a fungus growth upon the leaves and twigs and sometimes upon the fruit. It is black in color and when the attack is severe often gives the whole tree a blackened appearance. The fungus is no doubt closely related to the sooty mold of citrus trees (*Meliola camelliæ*), if not identical. Like the latter it draws its sustenance not from the tree directly, but from the sweet substance known as honeydew, which is produced by aphides, torpedo bugs, and related insects. It doubtless interferes with the leaves and other organs in the performing of their functions and so is indirectly an injury.

The remedy for this disease consists in removing the cause by destroying the insects.

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[a] Bordeaux mixture is prepared as follows: Place 6 pounds of bluestone (copper sulphate) in a sack and suspend in a barrel or other wooden or earthen vessel containing 25 gallons of water. In another barrel or tub slake 4 pounds of quicklime by adding water very slowly at first. Dilute with water the paste thus formed until the total bulk of milk of lime is 25 gallons. Pour the bluestone solution and the milk of lime at the same time into a third barrel, so that the two will unite in a single stream as they fall. Strain the mixture through a sack and it will ordinarily be ready for use. A test, however, should be made to determine whether there is any danger of injury to the foliage. This may be made by simply inserting the clean blade of a penknife in the mixture and retaining it there for a minute or two. When withdrawn, if there is no deposit of copper on the blade the mixture is safe for ordinary use. If copper should appear, more milk of lime must be added.

INSECTS.

APHIDES, SCALE INSECTS, AND THE TORPEDO BUG.

Several species of insects, more or less common, are recorded upon mangos from Hawaii. The attacks of aphis, or the "black fly," Aphididæ, have already been mentioned in connection with the growing of seedling stock. The so-called oleander scale, *Phenacaspis* (*Chionaspis*) *eugeniæ*; a scale insect, *Coccus* (*Lecanium*) *mangiferæ* and *Chrysomphalus ficus* are more or less frequently seen, but have not as yet done great damage to mangos. The common mealy bug (*Pseudococcus* sp.) has done considerable injury to the crop on a few trees which have been noticed. The "torpedo bug," a leaf-hopper (*Siphanta acuta*), has occurred in large numbers, particularly on the island of Hawaii, and has been the chief cause of the sooty mold referred to. This insect is preyed upon by a fungus disease of the genus Isaria.

THE MANGO WEEVIL.

The mango weevil (*Cryptorhynchus mangiferæ*), which attacks the seeds of mangos (Pl. III, fig. 3), was first observed in this Territory during the summer of 1905. In regard to its life history, habits, and control Mr. D. L. Van Dine writes as follows:[a]

Since the life cycle is passed within the seed and the female, as is customary with the species of this family, deposits the egg in the food of the larva the insect must have been introduced in fruit or seeds of the mango brought to the islands for propagation from India or possibly the Philippines. It is evident that the fruit is infested in the very early stages of its development for the reason that there is no indication of the entrance to the seed of the larva through the seed husk. The work of the very young larva is indicated, and since no point of entrance is to be observed it would seem that the length of the life cycle of the insect is somewhat longer than the time of development of the fruit, as shown by the fact that seeds removed from matured mangos contain the larval weevil.

In the first lot of mangos examined it was estimated that about 60 per cent were infested—that is, out of 44 seeds examined 28 contained either the advanced larval, pupal, or adult stages. The next lot, examined six days later at the same place, resulted as follows: Sixteen seeds each were taken of the No. 9, the Chutney, and the common Hawaiian variety; and of the No. 9, 11 were good and 5 infested; of the Chutney, 6 were good and 10 infested; and of the common variety, 8 were good and 8 infested. The following varieties planted in seed beds were examined: Twelve seeds each of the Chutney and the No. 1 were selected at random, and of the former 10 were infested and 2 were good; and of the latter 3 were infested and 9 were good. In both instances the Chutney shows the largest number of infested seeds.

By removing the husk of the seed the presence of the weevil is easily detected and therefore all seeds planted should be thus treated. This is good horticultural practice in any event. Until the distribution of this insect pest in the islands and its life cycle, habits, and food plants are better understood it is to be urged that mangos will not be indiscriminately distributed from place to place. At the beginning of the next mango season an inspection of the various districts will be made and it is hoped that by that time practical and efficient measures of controlling the pest can be given. If the insect is found to attack only the mango and its present distribution is determined as being confined to certain districts it may be that by a rigorous quarantine and the destruction of the crop the pest can be stamped out.

[a] The Hawaiian Forester and Agriculturist, August, 1905.

As to direct remedies, if it is found that infested fruit falls to the ground they should be collected and destroyed. It may be that, as is the practice with the plum curculio, the adult beetle can be jarred from the trees onto sheets in the early season before they infest the fruit, or if the adult feeds on the leaves of the mango they can be poisoned by spraying with Paris green or arsenate of lead.

VARIETIES OF MANGOS.

The varieties of mangos are almost innumerable. Watt [a] records having collected some 500 varieties in India. In Hawaii the writer has made notes on about 40 distinct forms, but this does not include all the different varieties that might be brought together. The mango is so variable that new varieties are constantly appearing, due either to this variability alone or to the crossing of pollen. The evidence of these crosses is quite distinctly marked in some forms. The following list includes the more important forms that are to be found in the islands. [b] Since the names by which these are known are more or less local in many cases, they will be designated by number, with the local name following when it is deemed to be of sufficiently general application.

SEEDLINGS IN HAWAII.

1. The so-called Hawaiian Sweet mango. This was the earliest variety to be introduced in the islands, having come probably from Mexico. It is now found everywhere in Hawaii where mangos are grown. Size medium; form as shown in Pl. IX, fig. 1; stem depressed; color light green with slight brownish tints before ripening, the green changing to yellow and the brown to pink as ripening proceeds; flavor good when well grown; juices abundant; texture fibrous; seed large; tree a free bearer.

2. Known as the "No. 9." This variety, now quite common in Hawaii, was introduced about twenty years ago under this name by Mr. Joseph Marsden, who at the same time added several other forms to the local collection. Form resembling the letter S; stem prominent; size from $3\frac{1}{2}$ to $4\frac{1}{2}$ inches long, from $2\frac{3}{8}$ to $2\frac{7}{8}$ inches broad and from 2 to $2\frac{1}{2}$ inches thick; color before fruit is mature green, turning to a pale yellow when ripe, with a slight blush of pink on the upper end of the exposed side; peeling qualities very good; texture variable but most specimens rather fibrous; flavor sweet but watery; flesh light yellow; seed small; tree an abundant bearer. The fruit appears to be quite resistant to the attacks of the mango blight.

3. Herbert No. 9. (Pl. IV, A.) The seed from which this variety has grown was introduced at the same time as the above and was

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[a] Dictionary of the Economic Products of India, Vol. V, p. 149.

[b] Numbered varieties without quotation marks are station record numbers only, so designated as a matter of convenience. Where the numbers are quoted the reference is to well-known varieties which are so named in Hawaii; e. g., "No. 9" refers to the variety widely known as "the number nine;" while 30 is a reference to the serial number in the following list.—J. G. S.

supposedly identical, being planted under the same number. The fruit, however, is very distinct, but bears a close resemblance to the last variety. The writer has designated it in honor of Mr. Allan Herbert, who planted the tree. Size rather smaller than the "No. 9;" form resembling that variety, but with the peculiar S shape still more marked; color dark yellow when ripe, with a very beautiful bright red on the exposed side, thus making it very distinct and one of the most attractive mangos. In other respects it is very similar to the last variety, but is apparently more subject to the blight.

4. Variously known as Kauai Chutney, the Java, etc. It is improperly called a chutney, as it lacks the characteristics of that group. Size large; form thick at the shoulders and almost round, while it tapers rapidly to a point at the stigmatic end; color varying from lemon yellow to saffron where exposed and when thoroughly ripe and more or less dotted with red spots which have a gray center where the epidermis is ruptured; peeling qualities fair; flesh rather brighter yellow than is found in the "No. 9;" texture exceedingly good for a seedling, there being no fiber except close to the seed; flavor very good. A distinguishing characteristic of this form is the large size of the leaves.

5. Sometimes improperly called the Mangosteen mango. Size small; form rather rounded, unlike most mangos; color green with dull red on the exposed side before ripening, but turning to a very beautiful bright red, thus making it one of the most ornamental of the mangos; texture fibrous; flavor poor; seed very large. It is very subject to the mango blight.

6. The Samoan mango, so called by Mr. Allan Herbert, who introduced the seed from Samoa. Size medium; form oblong (Pl. IV, B); color pale yellow with a bright tinge on the exposed cheek, occasionally striped; peeling qualities fair; texture good for a seedling, the fibers being very fine; flesh light yellow just under the rind, slightly darker within; flavor sweet, with abundant juice.

7. The Manila mango. This is sometimes spoken of as the Double-Pointed Manila. Size very large; form roundish with prominent stigmatic point giving rise to descriptive name; color light green tinged with yellow, approaching yellow orange when very ripe; peeling qualities good; texture very good, with no fibers except close to seed; flavor good, sweet, juicy; color of flesh yellow orange; seed thin.

8. This mango is sometimes locally known as the French, a term whose significance is uncertain. It might well be called the Wine, because of its exceedingly beautiful wine-colored rind, which takes a very high polish if gently rubbed with a soft cloth. Size medium to large; form oblong, rounded; texture fair; peeling qualities good; flavor rather too strong for the average taste.

9. The Strawberry. Size large; form roundish, uniform; color before ripening very light green overlaid on exposed side with dull

A, HERBERT NO. 9; B, SAMOAN.

red, which brightens in ripening; flavor very good; flesh light in color; seed medium.

10. Locally known as "No. 7." This variety was introduced, together with the "No. 9" and others, by Mr. Marsden. Size rather small; form exceedingly variable, great differences in shape being noticeable in fruit on the same tree; color a dull, somewhat dingy, shade of yellow orange, overlaid with a beautiful orange red on the exposed side; peeling qualities poor; texture inclined to be fibrous; flavor peculiar and not very pleasing; flesh dark; seed of medium size.

11. Locally known as "No. 5." This also was among the introductions of Mr. Marsden. It very closely resembles the common Hawaiian Sweet mango, but is rather broader at the stigmatic end. Color, flavor, peeling qualities, and texture are also much like those of the first variety described.

12. "Davis No. 11." This is a seedling from the "No. 11" mango, which has attained considerable fame in the West Indies and appears to have come quite true to kind, as this variety is reported to do with a fair degree of accuracy. It was introduced by Mr. Henry Davis and has received his name to distinguish it from another and very inferior form which has locally been known as the "No. 11." Size medium; form short, rounded, much depressed at the stem end; color light green, turning to orange yellow in ripening; peeling qualities excellent; texture very good; flavor excellent; color of flesh very dark; seed small.

13. This is known to a limited number of people as the Rainbow mango, the one tree of the variety known to the writer being in the Henry Davis homestead at Punahou, Honolulu. Size medium; form resembling that of the so-called French or Wine mango (see 8); color light green on the unexposed side before ripening, the exposed side being overlaid with dull red which brightens in ripening to orange red in dots or stripes, a much brighter red than in 8; peeling qualities good; texture fair; flesh light yellow; flavor good, resembling the "No. 7."

14. This variety is also frequently spoken of as the "Manila," but differs from 7 in that the stigmatic end is less prominent and hence it does not have the so-called double-pointed character of that form. Size one of the largest grown in the islands; flesh much lighter than in 7; texture hardly equal to it; flavor superior; seed larger than in the variety just referred to, but not large in comparison to the size of the fruit.

15. Summer apple. In size and form this closely resembles 12, but is very unlike it in other respects. Color a very light green and yellow, slightly orange tinted on the exposed cheek, and dotted with orange red; texture fair; flavor very poor; color of flesh rather light; seed medium size.

16. Philips No. 9. This is a form of the "No. 9" distinct from the ordinary form and from that described as Herbert "No. 9." Size smaller than either of the other varieties to which it is related; form

decidedly like the "No. 9," but with the stem end drawn out into a protuberance from one-fourth to one-half inch long; color similar on the unexposed side to "No. 9;" on the exposed side a dull red before the fruit is ripe, turning, in ripening, to a tint of orange red; peeling qualities excellent; texture fair; flavor fully equal, if not superior, to its allied forms.

17. This variety has some local reputation under the name of Peach mango. The original tree of the variety, at least in these islands, is in the Henry Davis homestead in Honolulu. Size medium; form resembling the Samoan (6); color before ripening bright green overlaid by dull red on the exposed side, the red brightening and the green becoming yellow during the ripening process; peeling qualities fair; texture good, quite free from fibers except near the seed; flavor very good, abounding in sweet juice; color of flesh almost as light as that of the "No. 9;" seed long and of medium thickness.

18. Locally known as the Nectarine. Size small; form short, rounded, rather heaviest on the dorsal side and about equal in length and breadth; color dark dull green, acquiring slight yellow tinges in ripening; flavor peculiar, attractive, having a slightly biting taste, supposed by some to resemble the nectarine. The flesh is characteristic, being the most highly colored that the writer has seen in any of the varieties of mangos.

19. The Long Manila. Size medium to large; form long, narrow; color light yellow; texture good; flavor very good; seed thin, flat. It appears to be the same as that known in Porto Rico under the name Manila.[a]

It will be observed that the term Manila is applied to several varieties grown in these islands, and means very little except that the original of the variety is supposed to have come from Manila.

20. This might be called the Green Flesh mango, because of the peculiar greenish yellow color of the flesh. Size small; form resembling the common Hawaiian Sweet mango; color a bright green with traces of yellow and brown on the exposed surface; peeling qualities good; texture poor; flavor sour and unpleasant; seed long, thin.

21. The Saffron. Size medium; form rather short, resembling Wootten Chutney (31); peeling qualities fair; color rich saffron; texture good; flavor good. The original tree of this variety in the islands is a seedling growing at Kalihi. It is one of the most esteemed of the local seedlings.

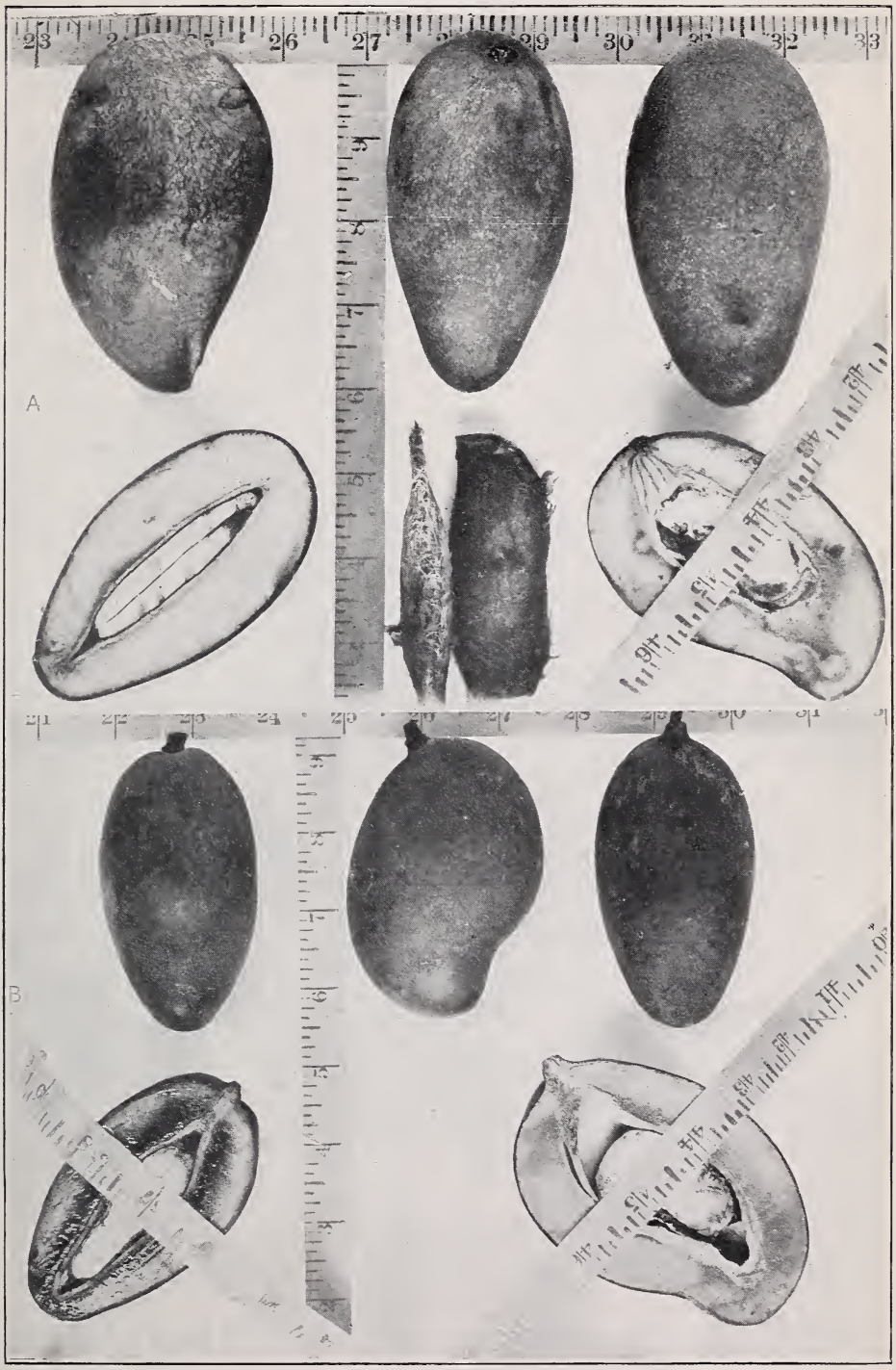
22. The Crescent. Size medium to large; form crescent-shaped, as shown in Plate V, with a tendency toward greatest enlargement on the exposed side, color a shade of yellow green on the unexposed side, even when ripe. In ripening, the exposed side takes on tinges of yellow, and when fully ripe becomes a shade of orange yellow. Peeling

[a] See "The Mango in Porto Rico," U. S. Dept. Agr., Bureau of Plant Industry Bul. 28.

CRESCENT.

Note the greatly reduced seed.

TWO VARIETIES OF CHUTNEY: A, VARIETY 29; B, VARIETY 28.



A, POINTED CHUTNEY; B, VARIETY 30, PROBABLY A CROSS BETWEEN "NO. 9" AND A CHUTNEY.

VARIETY 36.

Observe that the seed has been removed by simply cutting the mango longitudinally.

FIG. 1.—THE HAWAIIAN SWEET MANGO.

The first variety of mango introduced into the Hawaiian Islands.

FIG. 2.—WOOTTEN CHUTNEY.

AN INARCHED MANGO TREE IN FRUIT AT MOANALUA, OAHU, HAWAII.

qualities poor; texture very good, quite free from fiber; flavor excellent, sweet, and spicy; flesh light yellow with a slight tinge of green, except at the center close to the seed, where it is quite bright, approaching yellow orange; seed very thin and long, resembling the fruit in outline, greatly reduced within the husk showing tendency toward seedlessness. This is one of the most desirable of the sweet seedling mangos.

23. The Pineapple. A tree producing fruit known by this name locally is found on the Punchbowl slopes near Alapai street, Honolulu. It has received this name because of a resemblance in flavor, fancied or otherwise, to that of the pineapple. Size small; form resembling the "Davis No. 11;" color yellow splashed with red orange and orange red about the stem end; peeling qualities excellent; texture fair; flavor very fine; color of the flesh light, approaching orange yellow; seed large. This is a pretty mango and well suited for home use, but its large seed and its texture are against it.

24. The Vanilla. Size medium to large; form approaching roundness, with the stigmatic point more or less prominent; color quite uniform when ripe, passing through shades of yellow to those of orange yellow in ripening; peeling qualities good; texture fair to good; flavor rather too pronounced, with a slight bitter principle close to the seed; color of flesh orange; seed medium to large.

25. China. Size very large, one of the largest mangos in Hawaii; form resembling the Strawberry, with a slightly depressed stem; color a shade of yellow on the unexposed side and on the exposed side varying from red to orange red; peeling qualities good; texture good; flesh abundant in proportion to the size of the seed, very bright in color like that of the Vanilla; flavor rather lacking in delicacy, though sweet. It would seem that this variety, 24, and the so-called "Strawberry" are closely related. There is a similarity of flavor, form, and color of flesh. They differ in size and in color of rind.

26. The Walnut. Size small to very small, some specimens being not much larger than a walnut; form rounded, but not full on the stigmatic side, the stigmatic point being almost obliterated; color a shade of yellow on the unexposed side, the exposed side blushed with red and orange red at the stem end; peeling qualities fair; flavor fair; texture fair; seed large. It is valuable chiefly as a curiosity.

27. The Friel. Size small; form resembling on side view the "Davis No. 11" seedling, but viewed from the back it shows a rather gradual narrowing toward the stigmatic end; stigmatic point depressed, forming a small hole where there is often an elevation; stem very slightly depressed; color on the exposed side orange yellow when fully ripe, the unexposed side lighter, mingled with green; peeling qualities fair; texture fair; flavor fair; color of flesh light. Both this variety and 26 would probably be considerably changed by cultivation. They are now much neglected.

CHUTNEYS.

The term "chutney" should be used as the name of a class rather than of a variety, and does not signify a mango used chiefly for the manufacture of chutney, as might be supposed. The flavor of the members of this class is characteristic, and though not so sweet as most of the foregoing varieties, is nevertheless very agreeable and more esteemed by many than any of the sweeter kinds. There is a delightful acidity and spicy character, with a pleasing aroma and usually a characteristic odor in all parts of the plant. The differences between the forms sometimes is very slight, but in other cases it is well marked. They are sometimes separated into so-called acid chutneys and sweet chutneys, but it is quite probable that most of the forms classed as sweet chutneys are really the result of crosses between acid chutneys and some of the sweet mangos.

28. A rather small variety, specimens for description being taken from the residence property of Dr. W. D. Alexander, Honolulu. Form (Pl. VI, B) more rounded at the stigmatic end than in the case of varieties 29 and 30; color orange yellow dotted with a lighter tint of yellow, and with this exception quite uniform in shade throughout when ripe; the rind so thin and delicate that it does not readily separate from the flesh; texture good, there being very few fibers, except close to the seed; flavor a delightful tart taste, with abundant juices; flesh bright, a little lighter than yellow orange. Though in most cases this variety produces but one or two fruits from each flower cluster, this is sufficient to make a good crop.

29. This is one of the sweet chutneys, so called. Size medium to large for this class; form (Pl. VI, A) rather longer than 28, but shorter than 30; color the same as in 28; peeling qualities excellent; texture fair to good, but not equal to 28; flavor good, but not quite so sprightly as 28, but sweeter; seed of medium size.

30. This variety, as seen in Plate VII, B, has a tendency to the S shape of the "No. 9," and from its sweet flavor and other characters it would seem to be in all probability a cross between the "No. 9" and some one of the chutneys. The seeds which produced this variety and 29 are said to have come from the same tree, which adds to the probability that this is a cross. The color is lighter than in 29 and is uniform, except for the dots mentioned in 28 and 29. Peeling qualities good; texture excellent; seed of medium size.

31. Wootten Chutney. This name has been given to the variety because the only tree of the kind known is growing in the residence property of Mr. Harry Wootten in Honolulu. Size medium to large; form as shown in Plate IX, figure 2; color when ripe a shade between orange yellow and yellow orange, with tinges of pink and red at the stem end; peeling qualities fair; texture very good; flavor excellent; seed rather small for the size of the fruit. An important characteristic

of this variety is that while still solid it has a very beautiful color as if ripe, making it a desirable marketing form. It is one of the best of this class of mangos.

32. Moanalua Long Red. This is also in all probability a cross between some form of chutney and the sweet mango. The seeds which produced this tree and several others of the more normal type of chutney in the same locality are said to have come from a single parent tree on the island of Maui. The variety is so named because the tree producing this rather peculiar form is located at the Moanalua gardens. Size large; form long and pointed; color before ripening green on the unexposed surface, with a dull red on the exposed side which brightens to a red orange in ripening, a rather unusual color for a chutney; peeling qualities fair; texture fair; flavor lacking somewhat in the character of the chutneys; color of the flesh rather dark; seed medium.

33. The Lemon Chutney. Size large for this class; form resembling 30; color a light lemon yellow, dotted with lighter yellow after the manner of the chutneys; peeling qualities good; texture good; flavor good; seed medium size.

34. Pointed Chutney. Size medium; form rather long, tapering to a sharp point (Pl. VII, A); color yellow; peeling qualities good; texture fair, many specimens found with peculiar white lumps in the flesh, which, however, are thought not to be normal but due to the work of mealy bugs in large numbers on the exterior of the fruit throughout its time of growth; flavor decidedly acid; color of flesh very light just beneath the skin, ripening from the center outward with the outer layer quite firm, while the interior has become softened, a character found in many of the chutneys; seed of medium size, resembling the outline of the fruit; tree a vigorous grower and heavy cropper.

INARCHED VARIETIES.

Beside the large number of seedling varieties described, there are now in Hawaii quite a few of the world-famed Indian varieties, which have been introduced as inarched trees. To Mr. S. M. Damon is due the honor of having introduced at large expense the first trees of these kinds. Others have since been introduced from the Section of Seed and Plant Introduction of the U. S. Department of Agriculture. Some of Mr. Damon's trees have already fruited and through his kindness specimens of 35 and 36 were received, from which the descriptions have been made.

35. The Alphonse, Alphoos, or Alfoos. This is one of the most noted of the Indian mangos. Size medium to large; color greenish yellow on the unexposed side and running into yellow on the exposed side, where it is overlaid with light red; peeling qualities excellent; texture excellent, may be readily eaten with a spoon; flavor unique, with a peculiar mingling of acidity and sweetness in the bright-colored flesh.

36. The label of this variety was lost in the packing case, and it can not be identified with certainty at the present time. The size and form are as shown in Plate VIII. Color green blushed with a very beautiful red on the exposed side, approaching orange red; peeling qualities good; texture excellent; the fibers so reduced that the seed can be removed from a section of the fruit, as is done in preparing the avocado for eating. The flesh may then be eaten with a spoon, leaving only the rind. The pulp is light colored, tender, melting, and juicy. This is the mango which has thus far produced most heavily of any of the Indian varieties at Moanalua. (Pl. X.) The seed is of medium size.

The following varieties have not yet fruited in the islands.

37. Mulgoba. This very superior variety was one of the first grafted mangos to be introduced in the United States from India. It is illustrated by a colored plate in the Yearbook of the U. S. Department of Agriculture for 1901, and is there described as follows by Mr. W. A. Taylor:

> Form roundish, oblique, reniform; size large, weighing from three-fourths pound to 1 pound; surface smooth and undulating; color yellow, beautifully blushed with red and faintly dotted with numerous brown dots; skin thin, tough, tenacious; seed reniform, oval, rather large; fiber scanty, fine and tender; flesh rich, apricot yellow, very tender, melting and juicy, sweet, rich, fragrant; quality very good.
>
> The Mulgoba surpasses in flavor and quality the seedlings previously grown; but its most distinctly marked features of superiority are the tenderness of flesh and absence of the objectionable fiber and strong turpentine flavor common to most of the seedlings grown in this country. The tree is a strong, symmetrical grower and appears to be abundantly productive.

38. Totapari. Skin very smooth, altogether yellow, moderately tough; pulp concolorous with skin slightly fibrous; flavor excellent. It measures $4\frac{7}{8}$ inches by $2\frac{7}{8}$ inches. Both shoulders fall equally; beak small but distinct.—Woodrow.

39. Kavasji-Patel. Weight, 21 ounces; size, $5\frac{1}{2}$ inches by $3\frac{3}{4}$ inches; gathered green with white pulp for cooking; no fiber; a fine large cooking sort. Both shoulders falling; beak prominent.—Woodrow.

40. Fernandino. Weight, $9\frac{1}{2}$ ounces; size, $3\frac{7}{8}$ inches; skin bright crimson on the upper half, shading to pale yellow at the lower end; pulp very pale yellow, sweet, and of piquant flavor, but woolly; left shoulder level; right shoulder low; beak none.—Woodrow.

41. Pyrie. Weight, 8 ounces; size $3\frac{3}{4}$ inches by 3 inches; skin varying from red on the shoulder to pale yellow at the beak, very brightly colored pulp, soft creamy, of delicious delicate flavor. Both shoulders falling equally; stalk scar prominent; beak large. A first-class sort.—Woodrow.

42. Cambodiana. A very choice variety recently introduced from the Section of Seed and Plant Introduction of the U. S. Department of Agriculture.

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